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Transmitted herewith is the application for Reissue of U.S. Patent No. 5,659,944 issued on August 26, 1997.

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Title: METHOD FOR REPAIRING A CONNECTING DEVICE FOR THE ELECTRICAL CONNECTION AND FOR SUPPLYING AND REMOVING AWAY THE COOLANT TO AND FROM THE HOLLOW CONDUCTOR ELEMENTS....

Enclosed are:

- 7 Sheets of drawings
- Pages of Declaration and Power of Attorney
- Offer to surrender the original letters patent in accordance with 37 C.F.R. §1.178
- A Verified Statement to establish small entity status Under 37 C.F.R. §1.9 and 37 C.F.R. §1.27
- Petition
- A certified copy of an Abstract of Title
- An order for an Abstract of Title
- Consent of Assignee
- Other: Request For The Transfer of the Original Drawings, List of Inventors' Names and Addresses, Information Disclosure Statement, PTO Form-1449, Ref. (1), Request Under 37 C.F.R. 1.607

## Fee Calculation (37 C.F.R. §1.16(i) and (j))

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- The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Account No. 15-0030. A duplicate copy of this sheet is enclosed.
- A check in the amount of \$1,464.00 to cover the filing fee is enclosed.

Respectfully submitted,

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METHOD FOR REPAIRING A CONNECTING  
DEVICE FOR THE ELECTRICAL  
CONNECTION AND FOR SUPPLYING AND  
CARRYING AWAY THE COOLANT TO AND  
FROM THE HOLLOW CONDUCTOR  
ELEMENTS OF THE STATOR WINDING  
BARS OF ELECTRICAL MACHINES

This is a continuation-in-part of application Ser. No. 08/415,362, filed Apr. 3, 1995, now U.S. Pat. No. 5,557,837.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to a method for repairing or replacing a connecting device for electrical connection and for supplying and carrying away the coolant to and from the hollow conductor elements of the stator winding bars of electrical machines, in the case of which connecting device the hollow conductor elements and, if appropriate in the case of a stator winding which also comprises solid conductor elements as well as hollow conductor elements, all the conductor elements are surrounded by a metallic component and are brazed thereto and to one another, which component overhangs the conductor elements forming a water chamber and ends in a connecting fitting for coolant supply and carrying the coolant away.

2. Discussion of Background

In the stator winding overhang of water-cooled electrical machines, the coolant is supplied from annular header lines via insulating hoses to the so-called water chambers at the end of the conductor bars. The water chamber is formed by a connecting device in which the hollow conductor elements are surrounded by a metallic component and are brazed or soldered thereto and to one another. The metallic component overhangs the conductor elements to form this water chamber. It ends in a connecting fitting for coolant supply and carrying coolant away. The connecting device is at the same time also used as the electrical connection.

The connecting device is subject to high mechanical loads (vibration) during operation. Even very small leakages lead to consequential damage to the electrical machine. If such damage occurs, the brazed or soldered joints—if at all possible—must be replaced. In general, only the removal or even the complete replacement of the stator winding remains. There is thus a major requirement for a repair method which can be carried out without removal of the stator winding.

SUMMARY OF THE INVENTION

Accordingly, one object of the invention is to provide a novel method for repairing a connecting device of the generic type mentioned initially, which method can be carried out easily and manages without removal or even replacement of the stator winding, but at the same time makes possible leakage-free brazed or soldered joints.

This object is achieved according to the invention by a repair method which comprises removal of the existing connecting device from the bar end by inductive heating; cleaning the bar end in the region where the new connecting device is intended to be mounted; aligning the conductors of the end of the stator winding bar by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in the two orthogonal directions perpendicular to the length of the

stator winding bar; material-cutting machining of the end surface of the bar end, especially by milling; introducing narrow slots between adjacent conductor elements into the end of the bar in the transverse direction and vertical direction; pushing on a first connecting part which completely surrounds the bar end; filling remaining gaps between the first connecting part and the outer surfaces of the bar end with copper foil and/or braze foil; filling the narrow slots, which have been introduced into the end of the bar, with copper foil and/or braze foil; inductive heating of the first connecting part and of the bar end and brazing with the addition of braze; at least visual inspection of the braze joint thus created; fitting a second connecting part to the free end surface of the first connecting part by brazing; and testing the sealing of the connecting device created in this way.

This object is also achieved according to the invention by a repair method which comprises at the steps of removing an existing connecting device from the end of the stator winding bar; aligning the conductors of the end of the stator winding bar by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in two orthogonal directions perpendicular to the length of the stator winding bar; applying an electrically conductive first connecting part onto the end of the stator winding bar such that said first connecting part substantially surrounds said end of the stator winding bar; and sealing any gaps between the end of the stator winding bar and said electrically conductive first connecting part.

The invention is in this case based on the idea of managing with a minimum of modifications to the existing connecting device and at the same time retaining inspection of the quality of the repair measures at any time. This includes, *inter alia*, the deliberate creation of clean, defined, comparatively large-area braze points and the capability to fill the resulting gaps with filling strips made of copper and braze, or a combination of both, such that only extremely small gaps still remain which are later filled without any residue during brazing, as a result of the capillary effect. Furthermore, the splitting of the connecting device in two is to be emphasized, which allows accessibility, and thus the capability to inspect the braze joints to be created, at any time. This splitting in two furthermore makes possible great flexibility in the design of the two connecting parts, particularly with respect to their separating surfaces, as well. The latter can be designed such that, on the one hand, the brazing/testing of the first connecting part can be carried out easily whereas, on the other hand, the second connecting part makes possible the connection to the existing coolant lines as well as to the electrical connections virtually "seamlessly".

While the description refers to braze or brazing, it may be appreciated that the invention also encompasses the use of solder and soldering, and so the term "braze" or "brazing" as used in the remainder of this specification should be interpreted to optionally include solder or soldering.

Exemplary embodiments of the invention and further advantages which can be achieved thereby are explained in more detail in the following text, with reference to the drawing.

#### BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily obtained

as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. 1 shows a longitudinal section through a known connecting device for the electrical connection and for supplying and carrying away the coolant to and from the hollow conductor elements of the stator winding bars of electrical machines;

FIG. 2 shows a cross section through the connecting device according to FIG. 1, along the line AA in said figure;

FIG. 3 shows a cross section through the bar end close to the end surface after the introduction of slots between adjacent conductor elements;

FIG. 4 shows a longitudinal section through the bar end according to FIG. 3;

FIG. 5 shows a longitudinal section through a connecting device as is used for the repair method according to the invention, slots which have been introduced into the end surface of the conductor bar being filled with special filling pieces;

FIG. 6 shows the detail X from FIG. 5 on an enlarged scale;

FIG. 7 shows a longitudinal section through a connecting device as is used for the repair method according to the invention, the hollow conductor ends subsequently having been widened, as a modification to FIGS. 5 and 6;

FIG. 8 shows a longitudinal section through the bar end of FIG. 7 close to the end surface, after the introduction of holes at the meeting point of four hollow conductors, and subsequent filling of these holes with copper round material;

FIG. 9 shows a cross section through the bar end according to FIG. 8, along the line BB in said figure;

FIG. 10 shows a longitudinal section through a connecting device in which the separating surface between the two connecting parts is laid in the direction of the connecting fitting;

FIG. 11 shows a cross section through the bar end of a stator winding bar which also contains solid conductor elements, as well as hollow conductor elements;

FIGS. 12A and 12B are respectively sectional and side views schematically showing the brazing of the first connecting part to the end of the stator winding bar using a hydraulic pressing tool and an induction heating coil; and

FIG. 13 is a schematic orthogonal view of an embodiment in which the first connecting part has a window and a floating window cover plate for maintaining the aligned position of the conductor ends during the brazing of the first connecting part onto the bar end.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, wherein like reference numerals designate identical or corresponding parts throughout the several views, the object used as the basis for the repair method which is to be described in the following text is a known connecting device for the electrical connection and for supplying and carrying away the coolant from the hollow conductors of the stator winding bars of an electrical machine, as is illustrated schematically in FIGS. 1 and 2.

The stator winding bar which, in the case of the example is constructed only from hollow conductor elements 1, is provided at its end with a connecting device in the form of a metallic component 2. The latter surrounds the totality of

all the conductor elements 1, overhangs them externally to form a water chamber 3 into which the cooling channels 4 open into the conductor elements 1, and ends in a connecting fitting 5 for coolant supply and carrying the coolant away.

The conductor elements 1 are silver-brazed to one another and to the metallic component. The braze gaps, which are illustrated excessively large in FIG. 1 and FIG. 2 and are filled with braze are designated by 6. The electrical connection S (indicated by dashed lines in FIG. 1) of the connecting device is located in the case of the example on the outside of the water chamber 3, and has been omitted in FIG. 1 because it is not necessary for understanding of the invention.

After the machines have been operated for a time, leakages can occur at the braze joints. The wall of the water chamber 3 itself can also become unsound if—as is normal in a large number of relatively old machines—it is made of cast copper. The consequence is that cooling water passes into the winding overhang space or—as is far more dangerous—into the conductor bar, which must be avoided under all circumstances. Because of the confined spatial conditions in the winding overhang space, the replacement of such connecting devices is extremely tiresome. As a rule, removal of the stator winding is not possible, for economic reasons. The invention now comes into play here.

The repair method according to the invention is presented in summary form as follows, and comprises essentially the following method steps:

- a) removal of the existing connecting device (metallic component 2) from the bar end by inductive heating;
- b) cleaning the bar end in the region where the new connecting device is intended to be mounted;
- c) aligning the conductors of the end of the stator winding bar by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in the two orthogonal directions perpendicular to the length of the stator winding bar;
- d) material-cutting machining of the end surface of the bar end, especially by milling;
- e) introducing narrow slots 7 between adjacent conductor elements 1 into the end of the bar in the transverse direction and vertical direction in order to remove "old" braze between the conductor elements down to a pre-defined depth;
- f) pushing on a first connecting part 2a which is made of copper and completely surrounds the bar end;
- g) filling remaining gaps between the first connecting part 2a and the outer surfaces of the bar end with copper foil and/or braze foil;
- h) filling the narrow slots 7, which have been introduced into the end of the bar, with copper foil and/or braze foil or a combination of both;
- i) inductive heating of the first connecting part 2a and of the bar end and brazing with the addition of braze;
- j) at least visual inspection of the braze joint thus created;
- k) fitting a second connecting part 2b made of copper to the free end surface of the first connecting part 2a by brazing;
- l) testing the sealing of the connecting device created in this way.

In step a, the metallic component 2 is heated by inductive means to the melting temperature of the braze and is pulled

off the bar end. Devices for deliberate local heating of components and braze joints are covered by the prior art and for this reason are not explained in more detail.

This is followed, as step b, by the mechanical cleaning of the braze points, which can be done, for example, by brushing or polishing. In this case, the exfoliated material and porous old braze are removed down to the bare copper or bare braze.

After this, in step c, the conductors of the end of the stator winding bar are aligned by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in the two orthogonal directions perpendicular to the length of the stator winding bar. The conductor elements 1 of the end of the stator winding bar, with the existing insulation stripped therefrom, are inserted into an induction heating coil which may be of the type used in step a and a hydraulic press is positioned over the heating coil for pressing in the horizontal and vertical directions. The braze holding the conductors in position is then heated to above its flow point while the press applies pressure to align the conductors by closing the gaps therebetween.

After this—step d—the hydraulic press and heating coil are removed and the end surface of the conductor bar is machined by metal-cutting machining, preferably by milling, until a clean copper surface is achieved.

In step e, narrow slots 7 having a width  $b=0.5$  mm and a depth  $t=10-15$  mm are introduced into the former braze gaps between mutually adjacent conductor elements 1, as is illustrated in FIGS. 3 and 4. This can be done using a side-milling cutter which is mounted on an auxiliary device at the bar end. The essential feature in this case is that the width  $b$  of the slots is dimensioned such that the outer wall of the hollow conductor elements is also included in the milling process, so that the side wall of the slot 7 is machined, except for the conductor copper, as far as the crossing points 8 where four conductor elements abut against one another.

In step f, one half  $2a$  of a metallic connecting part is now pushed onto the bar end which has been prepared in this manner. This half may be manufactured from solid, rolled copper, or is forged, and is brought to the corresponding shape by metal-cutting machining; it is thus not a casting. The dimensions of the hole in this first half at the end of the bar side largely correspond to the original bar end. It overhangs the bar end by a certain amount  $s$ . Taking into account the subsequent fitting of the second connecting part  $2b$ , the excess amount should be selected to be as large as possible, as will be explained later in conjunction with FIG. 10.

Gaps which possibly still remain between the inner wall of the first connecting part  $2a$  and all the outer surfaces of the conductor bar are now (step g) filled with first filling strips 9. These first filling strips 9 have become known under the designation SILFOS and are offered in a wide range of compositions and thicknesses which may be between 0.1 mm and 1.2 mm. If required, copper-foil strips can also additionally be used in order to fill relatively large gaps as completely as possible as well.

The slots 7 are now filled with second filling strips 10 (in step h). Since the slot width  $b$  (to be filled) is now produced by the milling tool and is thus defined, filling strips 10 are preferably considered here which comprise a central copper layer 11 with braze layers 12, 13 arranged on both sides, as can be seen from the detailed illustration in FIG. 6. This results in the braze gaps being kept as small as possible, so

that all the gaps are filled during the subsequent brazing step i, as a result of the capillary effect.

The bar end prepared in this way with the first connecting part 2a pushed on is now inductively heated and brazed with the addition of braze (step i) to secure the first connecting part to the bar end.

There is also a concern that the aligned conductors at the end of the bar will lose their alignment during brazing step i. This possibility is minimized according to a feature of the invention illustrated in FIGS. 12A, 12B and 13. Here, step f is performed by inserting the conductor elements 1 of the end of the stator winding bar into a modified first connecting part 2aa having a window 2ab at one lateral wall thereof. A window plate 2ac, which has a thickness greater than that of the first connecting part 2aa, is fitted in the window 2ab through the intermediary of a braze strip 2ad. Prior to the heating of step i, pressure is applied to window plate 2ac in the arrow direction, for example via a conventional hydraulic press 102, which may be of the same type used in step c. The pressure retains the aligned positions of the conductor ends during the subsequent brazing (step i) by induction heating coil 100. A water jacket 104 having a cooling water flow controlled by the temperature sensed by the thermocouple 106 may be used to protect the remaining insulation on the conductors. Upon the solidification of the braze after step i, the bar end is unified with the part 2aa, the alignment of the conductor ends is maintained, and the window plate 2ac is unified with the first connecting part 2aa by the braze strip 2ad.

After the brazing of the first connecting part 2a, all the braze points are now inspected and investigated for freedom from porosity (in step j). A sealing test can optionally be carried out even at this stage, for example by provisional closure of the first connecting part and pressing off, for example using helium gas, for example from the other side of the machine.

After completion of the inspection and, if appropriate, after reworking of the braze points, the second connecting part 2b is now placed onto the first connecting part 2a (in step k), with the interposition of braze foils (not shown in FIG. 5), and is brazed thereto. Like the first, this second part is also manufactured from solid copper and is brought to the appropriate shape by metal-cutting machining; it is thus not a casting. For reasons of completeness, it should be mentioned at this point that the electrical connection is made to the second connecting part 2b in the case of this and all further variants, and the second connecting part 2b has been prepared with the first, even before the brazing. In order to enlarge those end surfaces of both connecting parts 2a, 2b which are to be brazed to one another, and in order to simplify the mutual adjustment, these connecting parts 2a, 2b are stepped on their end surfaces. The silver braze which is used for this joint may in this case have a lower melting temperature than that used for brazing the first connecting part 2a to the bar end, in order to prevent damage to those silver-braze joints. Silver brazes having an increased silver content are used in this case.

Completion of all the braze joints is followed by final inspection according to step l, in which the test for sealing by pressing off using, for example, helium gas, is carried out as well as visual inspection.

In addition to the repair method which has been described in the preceding text and is at the moment regarded as being preferred by the applicant, modifications are possible without departing from the framework covered by the invention. One of these modifications relates in particular to method step h. It is shown, by way of example, in FIGS. 7 to 9.

After the first connecting part 2a has been pushed on in step f, and any remaining gaps between this connecting part 2a and the outer surfaces of the bar end have been filled, "conventional" braze foil strips with a thickness of approximately 1 mm are inserted into the slots 7. The hollow conductor elements 1 are then widened at their end until the slots 7 which have been milled in step 4 are closed at the end (cf. FIG. 7 in which the slots which are illustrated excessively wide are already filled with silver braze). The remaining critical gaps 8 at the point where four adjacent conductors meet, which gaps 8 cannot be closed by this widening, are now drilled down to a depth which may be approximately 13 to 15 mm. It has in this case been found that it is sufficient to accomplish this using a drill of 1 to 1.5 mm. Pins 14, which are 13 to 15 mm long and are made of copper round material, are now inserted into these holes (cf. FIGS. 8 and 9), and the gaps are in this way closed. The purpose of this procedure is virtually to close all the gaps in order to create capillaries for the liquid braze into which it can flow and can also remain therein. Steps i to 1 then follow in the indicated manner.

As already mentioned, two brazing processes which are successive both in time and in space, must be carried out in the case of the repair method according to the invention. In the case of such a process, there is always the risk of the quality of the preceding brazing being adversely affected during a subsequent brazing process. In the present case, this risk can be avoided on the one hand by suitable selection of the melting point of the silver braze. Another possibility is to design the connecting device, more precisely the position of the separating surfaces of the two connecting parts 2a and 2b, such that the second braze point is as far as possible away from the first, that is to say to enlarge the distance s (cf. FIGS. 5 and 7). However, this is dependent on the structural characteristics at the site of the repair. In the case of connecting devices having a comparatively large extent, as is illustrated schematically in FIG. 10, the separating surface T of the two connecting parts 2a and 2b can be located a very long distance away from the end surface of the conductor bar and towards the connecting fitting 5. However, nothing is changed in the described repair method, at most with the exception that one and the same braze can now be used for both silver-brazing operations.

The repair method according to the invention has been described in the preceding text with reference to a conductor bar consisting only of hollow conductor elements 1. It is self-evident that the method is also suitable for stator winding bars which also have solid conductor elements 15 as well as hollow conductor elements 1 (cf. FIG. 11). In the case of such an arrangement, and following the teaching of the invention, after removal of the original connecting device, cleaning of the outer surfaces of the bar end, aligning the conductor ends and milling its end flat, narrow slots are introduced between all the conductor elements 1, 15, that is to say also between adjacent hollow and solid conductor elements as well as between two adjacent solid conductor elements 15. The alternative (filling the slots only with braze foil and widening the hollow conductor elements 1 indicated in step h is admittedly possible here, but depends on the distribution of the hollow conductor elements in the conductor bar itself).

The essential feature in all the design variants of the invention is to ensure in each case that all the earlier braze points are machined down to a predetermined depth seen from the bar end, and can thus be wetted well by the "new" braze, and that all gaps which are too large for the brazing are avoided or filled (capillary brazing).

Obviously, numerous modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of

the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A method of repairing a joint between conductor elements of a stator winding bar of an electrical machine and a connecting device connected to an end of the stator winding bar for providing electrical connection and coolant flow for the conductor elements, the method comprising the steps of:

removing an existing connecting device from the end of the stator winding bar;

aligning the conductors of the end of the stator winding bar by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in two orthogonal directions perpendicular to the length of the stator winding bar;

forming slots in the end of the stator winding bar and at locations such that said slots extend to locations where said conductor elements abut one another;

applying an electrically conductive first connecting part onto the end of the stator winding bar such that said first connecting part substantially surrounds said end of the stator winding bar; and

sealing said slots and any gaps between the end of the stator winding bar and said electrically conductive first connecting part.

2. The method of claim 1 wherein said sealing step comprises:

filling gaps between said first connecting part and an outer surface of said end of the stator winding bar with at least one first filler element;

filling said slots with at least one second filler element; and

heating at least one of said end of the stator winding bar and said first connecting part, wherein at least one of said first and second filler elements comprise at least one layer of a material which melts during said heating step, and adding sufficient additional meltable material to assure complete sealing of said gaps and slots.

3. The method of claim 1 wherein said sealing step comprises:

filling gaps between said first connecting part and an outer surface of said end of the stator winding bar with at least one first filler element;

filling said slots with at least one second filler element; and

inductive heating at least one of said end of the stator winding bar and said first connecting part, wherein at least one of said first and second filler elements comprise at least one layer of a material which melts during said heating step, and adding sufficient additional meltable material to assure complete sealing of said gaps and slots.

4. The method of claim 3 including the further steps of: visually inspecting said sealed gaps via said first connecting part; and

applying an electrically conductive second connecting part onto said first connecting part so as to form a complete connecting part.

5. The method of claims 1 including a step of cleaning said end of the stator winding bar after the step of removing the existing connecting device.

6. The method of claims 1 including a step of material-cutting machining said end of the stator winding bar after the step of removing the existing connecting device.

7. The method of claim 6 wherein said material-cutting machining comprises milling.
8. The method of claims 1 wherein at least one of said conductor elements is hollow.
9. The method of claims 1 wherein at least one of said conductor elements is solid.
10. The method of claims 1 wherein said step of removing an existing connecting device from the end of the stator winding bar comprises inductive heating at least one of said stator winding bar and said connecting device.
11. The method of claim 1 wherein groups of four of said conductor elements abut one another at points and said slots extend to said points.
12. The method of claim 10 wherein said slots form straight lines.
13. The method of claim 10 wherein said slots form intersecting sets of straight lines which intersect at said points.
14. The method of one of claims 2 wherein at least one of said first and second filler elements comprise a spacer element.
15. The method of one of claims 3 wherein at least one of said first and second filler elements comprise a spacer element.
16. The method of claim 8 including, after said slot forming step, the step of widening said hollow conductor elements at said end of the stator winding bar until edges of adjacent conductor elements touch one another.
17. The method of claim 16 wherein groups of four of said conductor elements abut one another at points and said slots extend to said points, including the step of drilling holes into said bar at said points and inserting pins of meltable material into the drilled holes.
18. A method of repairing a joint between conductor elements of a stator winding bar of an electrical machine and a connecting device connected to an end of the stator winding bar for providing electrical connection and coolant flow for the conductor elements, the method comprising the steps of:
  - removing an existing connecting device from the end of the stator winding bar;
  - aligning the conductors of the end of the stator winding bar by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in two orthogonal directions perpendicular to the length of the stator winding bar;
  - applying an electrically conductive first connecting part onto the end of the stator winding bar such that said first connecting part substantially surrounds said end of the stator winding bar; and
  - sealing any gaps between the end of the stator winding bar and said electrically conductive first connecting part.
19. The method of claim 18 including the step of maintaining the alignment of the conductors of the end of the stator winding bar during said sealing step.
20. The method of claim 19 wherein said maintaining step comprises:
  - applying, in said applying step, an electrically conductive first connecting part having a window covered by a floating cover plate;
  - filling gaps between said first connecting part and an outer surface of said end of the stator winding bar with at least one braze filler element;
  - applying pressure to the conductors of the end of the stator winding bar via said floating cover plate; and

heating, in said sealing step, at least one of said end of the stator winding bar and said first connecting part to melt said at least one braze filler element, while maintaining said pressure.

21. A method of repairing a joint between conductor elements of a stator winding bar of an electrical machine and a connecting device connected to an end of the stator winding bar for providing electrical connection and coolant flow for the conductor elements, the method comprising the steps of:

removing an existing connecting device from the end of the stator winding bar;

cleaning said end of the stator winding bar;

aligning the conductors of the end of the stator winding bar by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in the two orthogonal directions perpendicular to the length of the stator winding bar;

material-cutting machining said end of the stator winding bar;

forming slots in the end of the stator winding bar and at locations such that said slots extend to locations where said conductor elements abut one another;

applying an electrically conductive first connecting part onto the end of the stator winding bar such that said first connecting part substantially surrounds said end of the stator winding bar;

filling gaps between said first connecting part and an outer surface of said end of the stator winding bar with at least one first filler element;

filling said slots with at least one second filler element;

sealing said gaps and slots by heating at least one of said end of the stator winding bar and said first connecting part, at least one of said first and second filler elements comprising at least one layer of a material which melts during said heating step, and adding sufficient additional meltable material to assure complete sealing of said gaps and slots;

visually inspecting said sealed gaps via said first connecting part;

applying an electrically conductive second connecting part onto said first connecting part so as to form a complete connecting part; and

testing the repaired joint.

22. The method of claim 18 including the step of maintaining the alignment of the conductors of the end of the stator winding bar during said sealing step.

23. The method of claim 19 wherein said maintaining step comprises:

applying, in said step of applying an electrically conductive first connecting part onto the end of the stator winding bar, an electrically conductive first connecting part having a window covered by a floating cover plate;

applying pressure to the conductors of the end of the stator winding bar via said floating cover plate; and

heating, in said sealing step, at least one of said end of the stator winding bar and said first connecting part to melt said at least one first filler element, while maintaining said pressure.

--24. A method for providing an electrical and fluid connector on an electro-fluidic conductor, said electrical and fluidic connector having a first member and a second member that are separate and both electrically conductive, said second member having a fluid port that facilitates fluidic connection to a fluid conductor and said second member being configured to facilitate electrical connection to an electrical conductor, said method comprising the steps of:

(a) securing said first member to said electro-fluidic conductor such that said first member encircles an end portion of said electro-fluidic conductor and forms a fluid tight seal thereto, and electrically connects therewith; and

(b) matingly connecting said first member to said second member such that said first member and said second member define a hollow inner chamber that comprises a fluid tight chamber for passing fluid between said electro-fluidic conductor and said fluid port of said second member, and wherein said first member and said second member themselves define an electrical connection between said electro-fluidic conductor and said electrical conductor when said electrical conductor is attached to said second member.

25. The method of claim 24, wherein said method further comprises the step of removing a defective electrical and fluidic connector from said electro-fluidic conductor prior to said securing step (a).

26. The method of claim 25, wherein said defective electrical and fluidic connector comprises a single piece electrical and fluidic connector such that said method includes removing said single piece electrical and fluidic connector from said electro-fluidic conductor prior to said securing step (a).

27. The method of claim 25, wherein said removing said defective electrical and fluidic connector comprises the step of heating said defective electrical and fluidic connector to soften an existing brazing alloy securing said defective electrical and fluidic connector to said electro-fluid conductor such that said removing step is facilitated.

28. The method of claim 24, wherein said method further comprises the step of verifying said fluid tight seal of said securing step (a) prior to said matingly connecting step (b).

29. The method of claim 28, wherein said verifying step includes affixing a test cap to said first member and pressurizing said electro-fluidic conductor such that any leaks between said first member and said electro-fluidic conductor are detected.
30. The method of claim 24, wherein said securing step (a) comprises the step of brazing said first member to said electro-fluidic conductor using a first brazing alloy.
31. The method of claim 30, wherein prior to said brazing step, said securing step (a) includes placing said first brazing alloy around said end portion of said electro-fluidic conductor.
32. The method of claim 30, wherein said matingly connecting step (b) comprises brazing said first member to said second member using a second brazing alloy having a lower melting temperature than a melting temperature of said first brazing alloy.
33. The method of claim 32, wherein said connecting step (b) comprises heating said first member and said second member to a temperature at least as high as the melting

temperature of the second brazing alloy but lower than the melting temperature of the first brazing alloy such that the first brazing alloy does not melt during said connecting step (b).

34. The method of claim 24, wherein said first member has at least one groove on an outer surface thereof, and wherein said method further comprises inserting a third brazing alloy into said at least one groove such that said matingly connecting step (b) comprises brazing said first member to said second member using said third brazing alloy.

35. The method of claim 34, wherein said matingly connecting step (b) comprises inserting said first member flush into said second member prior to said brazing of said first member to said second member.

36. The method of claim 35, wherein said method includes placing a ribbon alloy on an outer surface of said first member after said inserting of said third brazing alloy into said at least one groove and prior to said inserting said first member into said second member, said ribbon alloy securing said first

member to said second member as a result of  
said brazing of said first member to said  
second member.

37. The method of claim 24, wherein said  
metably connecting step (b) comprises  
inserting said first member into said second  
member and brazing said first member to said  
second member.

38. The method of claim 37, wherein said  
method includes placing a ribbon alloy on an  
outer surface of said first member prior to  
said inserting said first member into said  
second member.

39. The method of claim 37, wherein said  
method further comprises applying pressure  
that forces said first member into said second  
member during said brazing of said first  
member to said second member.

40. The method of claim 24, wherein said  
method further comprises the step of  
connecting said electrical conductor and said  
fluidic conductor to said electrical and  
fluidic connector for facilitating electrical  
and fluidic connection thereto.

41. The method of claim 40, wherein said step  
of connecting said electrical conductor and

said fluidic conductor to said electrical and fluidic connector comprises brazing said electrical conductor and said fluidic conductor to said electrical and fluidic connector.

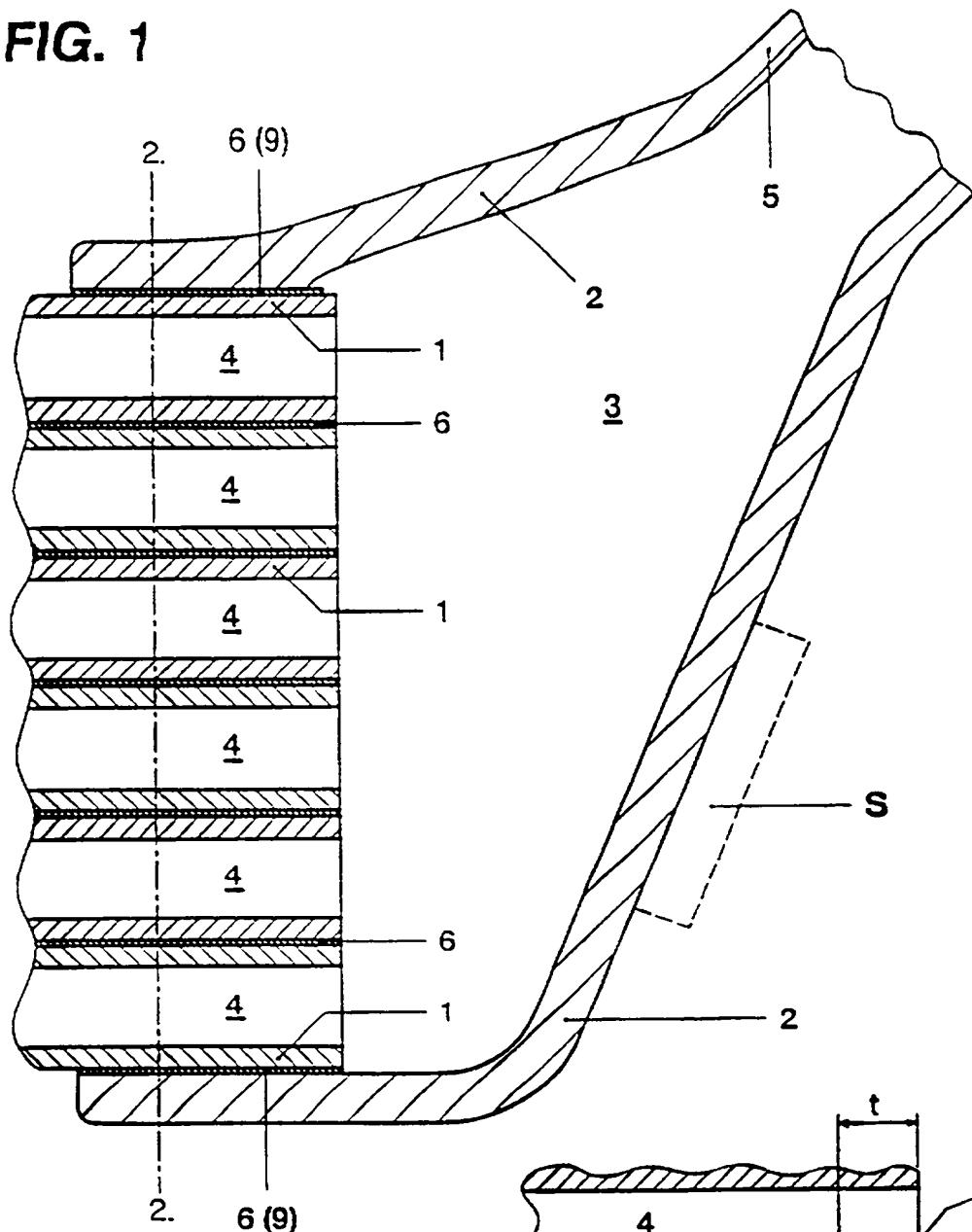
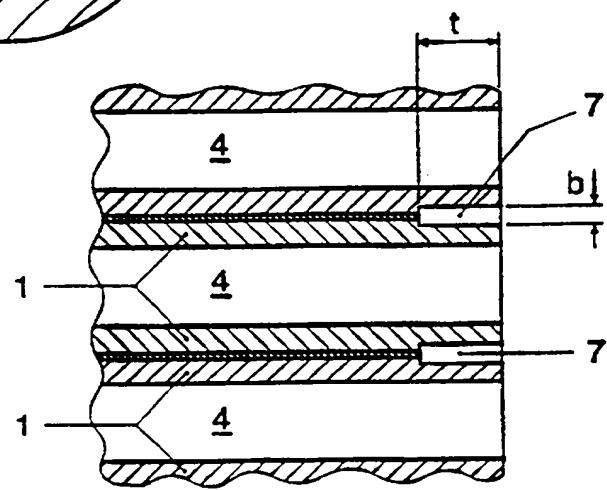
42. The method of claim 41, wherein said fluidic conductor and said electrical conductor comprise a single conductive pipe such that said step of connecting said electrical conductor and said fluidic conductor to said electrical and fluidic conductor comprises brazing said single conductive pipe to said electrical and fluidic connector.

43. The method of claim 40, wherein said method further comprises the step of insulating the electrical and fluidic connector.

44. The method of claim 24, wherein said electro-fluidic conductor comprises a stator bar in a water cooled electric machine, and wherein said securing step (a) and said matingly connecting step (b) are performed while said stator bar is installed in said water cooled electric machine.--

## ABSTRACT

A method of repairing a joint between conductor elements of a stator winding bar of an electrical machine and a connecting device connected to an end of the stator winding bar for providing electrical connection and coolant flow for the conductor elements includes the steps of removing an existing connecting device from the end of the stator winding bar; aligning the conductors of the end of the stator winding bar by heating the bar end to above the flow point of the braze holding the conductors in position while simultaneously holding the conductors of the end of the stator winding bar under compression in two orthogonal directions perpendicular to the length of the stator winding bar; forming slots in the end of the stator winding bar and at locations such that the slots extend to locations where the conductor elements abut one another; applying an electrically conductive first connecting part onto the end of the stator winding bar such that the first connecting part substantially surrounds the end of the stator winding bar and sealing the gaps and slots.

**FIG. 1****FIG. 4**

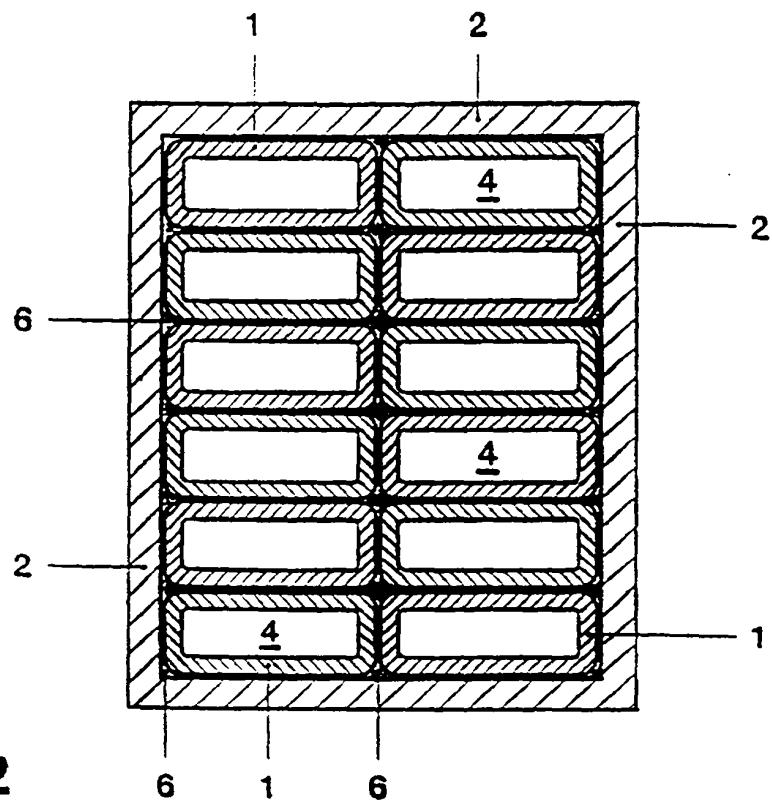


FIG. 2

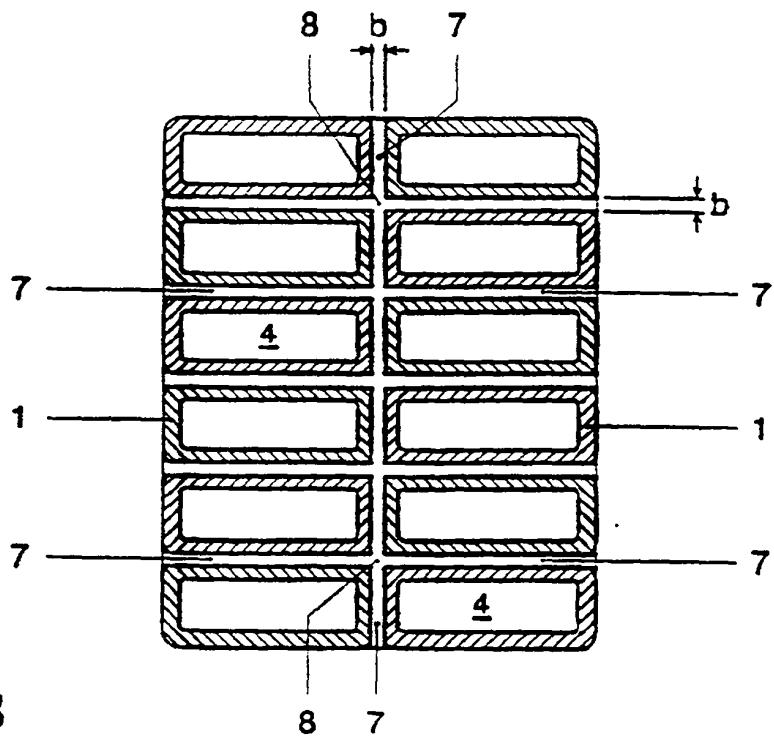
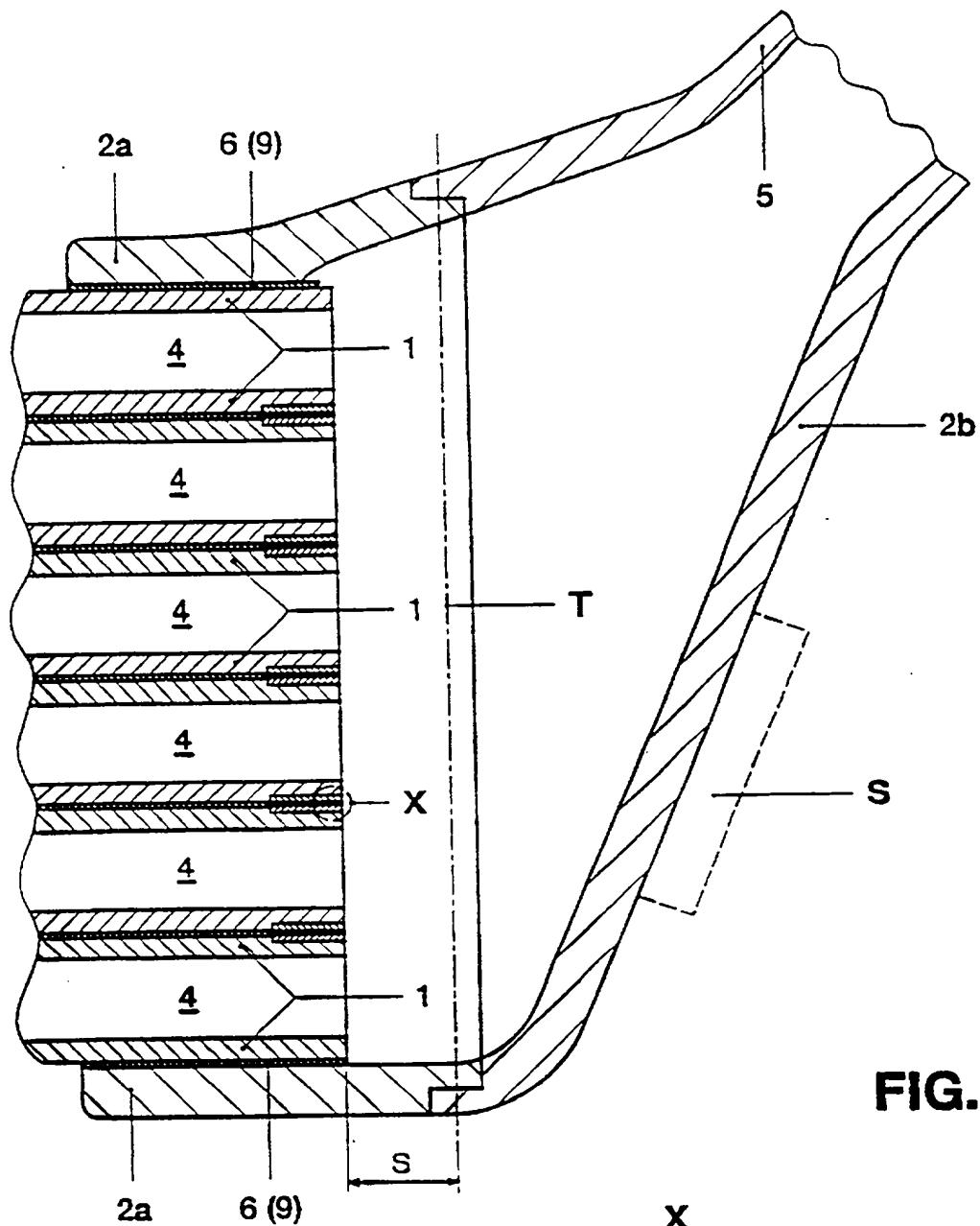
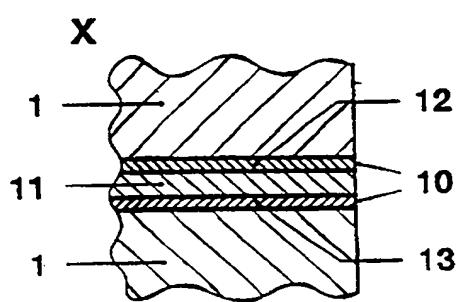
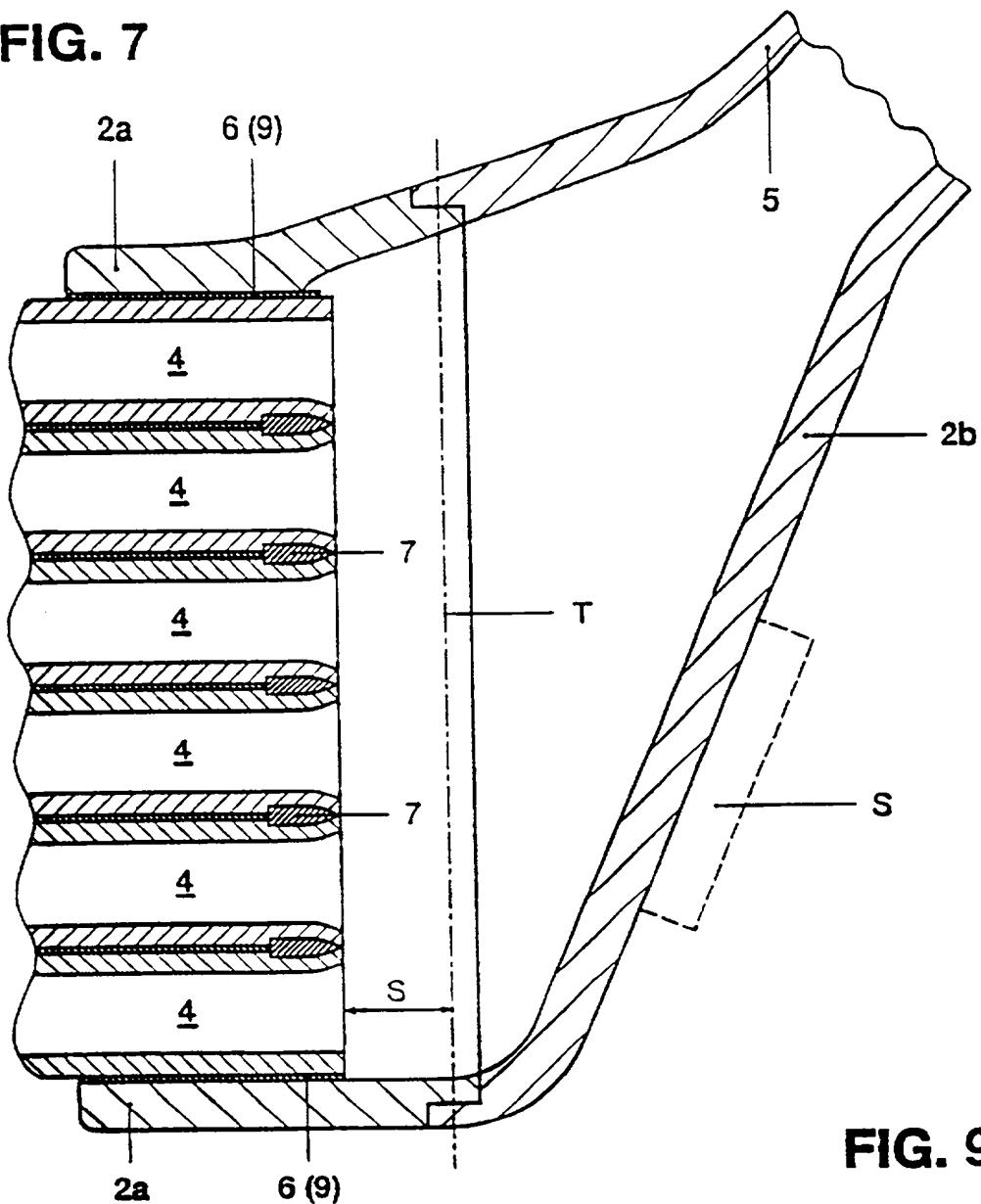
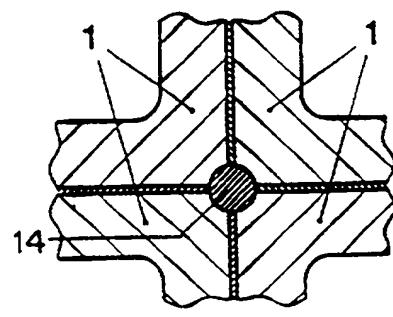
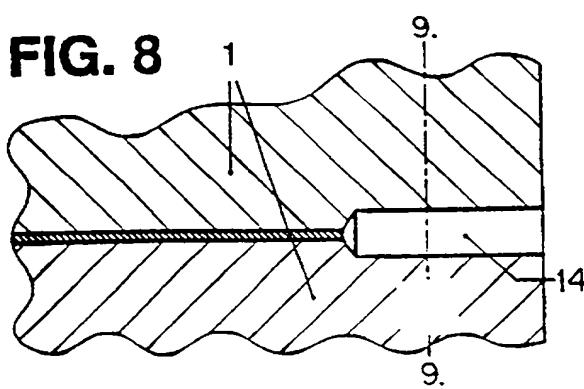
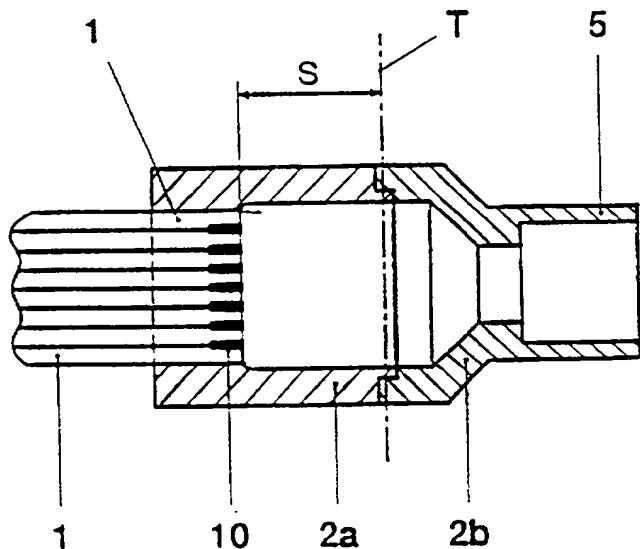
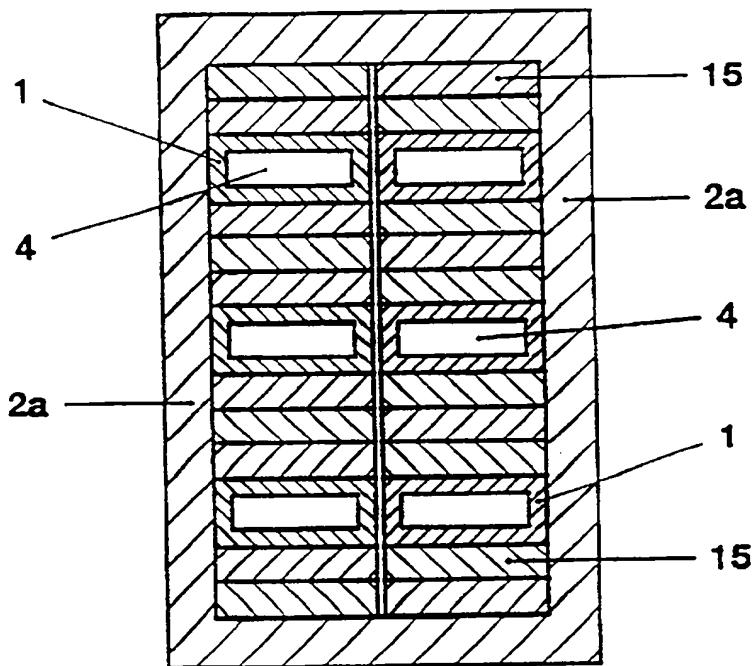


FIG. 3

**FIG. 5****FIG. 6**

**FIG. 7****FIG. 9**

**FIG. 10****FIG. 11**

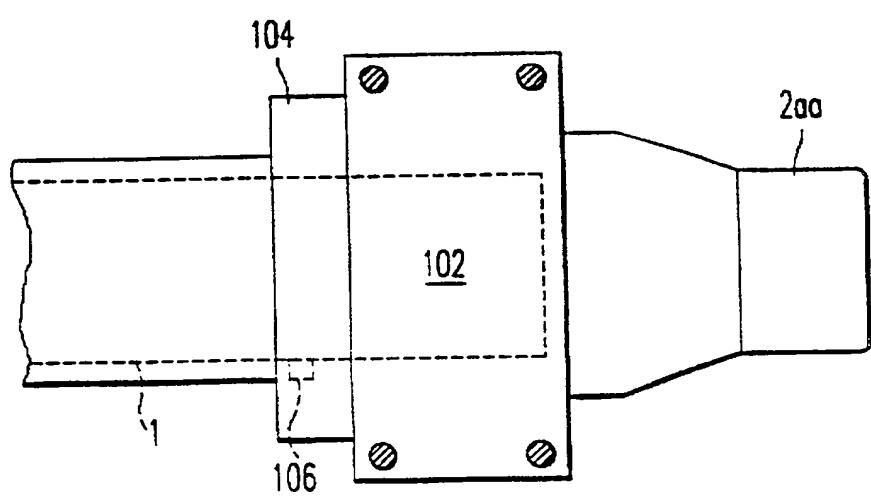
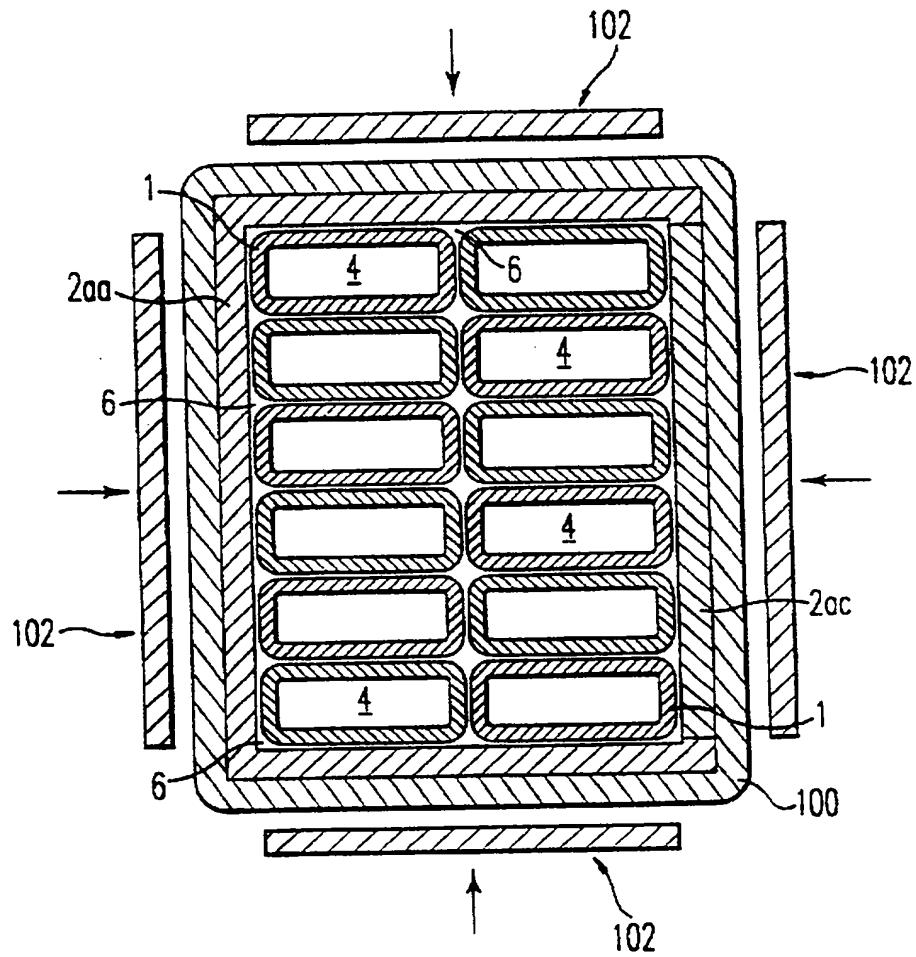
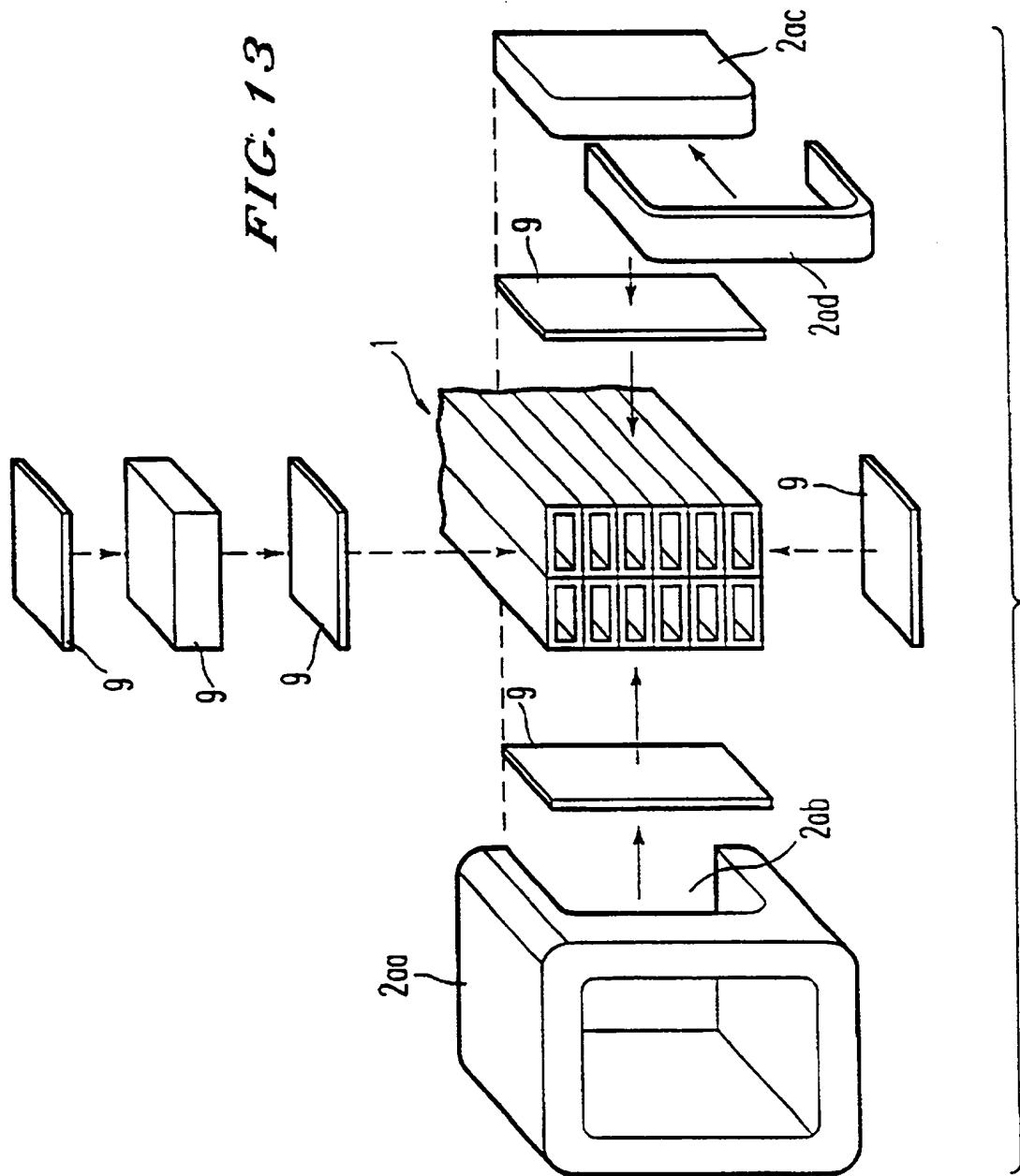
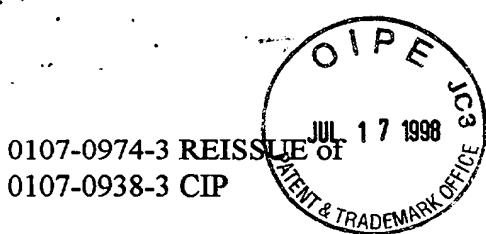




FIG. 13





IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE APPLICATION OF : :

ALFRED THIARD-LAFORET ET AL : EXAMINER:

APPLICATION NO. 08/966,368 : :

FILED: NOVEMBER 7, 1997 : GROUP ART UNIT: 3206

FOR: METHOD FOR REPAIRING A  
CONNECTING DEVICE FOR THE  
ELECTRICAL CONNECTION AND...

DECLARATION UNDER 37 C.F.R. 1.175 AND CONSENT OF ASSIGNEE

HONORABLE COMMISSIONER OF PATENTS & TRADEMARKS  
WASHINGTON, D.C. 20231

SIR:

We, the undersigned inventors hereby declare that:

1. Our residence, Post Office address and citizenship are stated below next to our names.
2. We believe that we are the original, first and joint inventors of the invention entitled  
METHOD FOR REPAIRING A CONNECTING DEVICE FOR THE ELECTRICAL  
CONNECTION AND FOR SUPPLYING AND CARRYING AWAY THE COOLANT TO  
AND FROM THE HOLLOW CONNECTOR ELEMENTS OF THE STATOR WINDING  
BARS OF ELECTRICAL MACHINES, described and claimed in Letters Patent No.  
5,659,944 (hereinafter '944 patent) issued on August 26, 1997.

3. We hereby claim foreign priority benefits under Section 119 of Title 35 United States Code of German Application no. 195 02 308.0, filed on January 26, 1995.

4. We also claim the benefit of the filing date of U.S. patent Application Serial no. 415,362, filed on April 3, 1995 and now U.S. patent no. 5,557,837.

5. We have reviewed and understand the contents of the above mentioned specification, including the claims, as amended by any amendment specifically referred to in the present declaration.

6. We acknowledge the duty to disclose information known by us to be material to the patentability of this application as defined in Section 1.56 of 37 C.F.R.

7. We verily believe the original patent to be wholly or partly inoperative or invalid by reason of our claiming less than we had a right to claim in the patent.

7. All of the errors resulting in our claiming less than we had a right to claim arose without any deceptive intention.

8. A first error resulting our claiming less than we had a right to claim is the failure of the '944 patent to include a claim reciting a method for providing an electrical and fluid connector on an electro-fluidic conductor, said electrical and fluidic connector having a first member and a second member that are separate and both electrically conductive, said second member having a fluid port that facilitates fluidic connection to a fluid conductor and said second member being configured to facilitate electrical connection to an electrical conductor, said method comprising the steps of (a) securing said first member to said electro-fluidic conductor such that said first member encircles an end portion of said electro-fluidic conductor and forms a fluid tight seal thereto, and electrically connects therewith; and (b) matably connecting said first member to said second member such that said first member and

said second member define a hollow inner chamber that comprises a fluid tight chamber for passing fluid between said electro-fluidic conductor and said fluid port of said second member, and wherein said first member and said second member themselves define an electrical connection between said electro-fluidic conductor and said electrical conductor when said electrical conductor is attached to said second member.

9. The undersigned declare further that all statements made herein of their own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this application or any patent issuing thereon.

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Date 12. July 1998

CONSENT OF ASSIGNEE

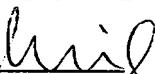
U.S. Patent 5,659,944, issued on August 26, 1997 to Thiard-Laforet, et al has been assigned to Asea Brown Boveri AG of Switzerland, which is the complete assignee of the above-referenced patent, by an assignment recorded at Reel 8232, Frames 604-606. The undersigned herein certifies that he has reviewed the assignment recorded at said reel and frame, and that to the best of his knowledge and belief title is in the above-noted assignee.

The undersigned further certifies that he is an officer of the assignee, Asea Brown Boveri AG, having the authority to consent to the reissue patent application, and so consents thereto.

The undersigned declares further that all statements made herein of his own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this application or any patent issuing thereon.

NameX Dr. Gert Lück

Asea Brown Boveri AG

SignatureX 

TitleX Vice President

DateX 13.07.1998

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PATENT, TRADEMARK AND COPYRIGHT LAW  
AND RELATED FEDERAL AND STATE UTIGATION



Docket No. 0107-0974-3 REISSUE

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GEORGE F. LESMES\*

\* BAR MEMBERSHIP OTHER  
THAN VIRGINIA  
† JAPANESE PATENT ATTORNEY  
\* REGISTERED PATENT AGENT

HONORABLE COMMISSIONER OF PATENTS AND TRADEMARKS  
WASHINGTON, DC 20231

Re: U.S. Serial No. 08/966,368  
Applicant: ALFRED THIARD-LAFORET ET AL  
Title: METHOD FOR REPAIRING A  
CONNECTING DEVICE FOR THE...

Commissioner:

Attached hereto for filing are the following papers:

**DECLARATION UNDER 37 C.F.R. 1.175 AND CONSENT OF ASSIGNEE  
NOTICE TO FILE MISSING PARTS...  
PETITION FOR EXTENSION OF TIME  
INFORMATION DISCLOSURE STATEMENT, PTO FORM-1449**

Our check in the amount of \$ 950.00 is attached covering any required fees. In the event any variance exists between the amount enclosed and the Patent Office charges for filing the above-noted documents, including any fees required under 37 CFR 1.136 for any necessary Extension of Time to make the filing of the attached documents timely, please charge or credit the difference to our Deposit Account No. 15-0030. A duplicate of this sheet is enclosed.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,  
MAIER & NEUSTADT, P.C.

*Gregory J. Maier*  
Gregory J. Maier  
Registration No. 25,599  
Robert T. Pous  
Registration No. 29,099  
Attorneys of Record

0107-0974-3 REISSUE of  
107-938-3 CIP

IN THE UNITED STATES PATENT & TRADEMARK OFFICE

IN RE PATENT OF :  
ALFRED THIARD-LAFORET ET AL :  
SERIAL NO.: (Application to reissue :  
Patent No. 5,659,944 issued on :  
August 26, 1997) :  
FILED: JANUARY 26, 1996 :  
FOR: METHOD FOR REPAIRING A CONNECTING DEVICE  
FOR THE ELECTRICAL CONNECTION...

REQUEST UNDER 37 C.F.R. 1.607

ASSISTANT COMMISSIONER FOR PATENTS  
WASHINGTON, DC 20231

SIR:

Applicants herein request the declaration of an  
interference between the above-referenced application and U.S.  
patent 5,573,414, issued on November 12, 1996 to Taillon et  
al. A proposed count is set forth below:

COUNT

A method for providing an electrical and fluid connector  
on an electro-fluidic conductor, said electrical and fluidic  
connector having a first member and a second member that are  
separate and both electrically conductive, said second member  
having a fluid port that facilitates fluidic connection to a  
fluid conductor and said second member being configured to  
facilitate electrical connection to an electrical conductor,  
said method comprising the steps of:

(a) securing said first member to said electro-fluidic

conductor such that said first member encircles an end portion of said electro-fluidic conductor and forms a fluid tight seal thereto, and electrically connects therewith; and

(b) matably connecting said first member to said second member such that said first member and said second member define a hollow inner chamber that comprises a fluid tight chamber for passing fluid between said electro-fluidic conductor and said fluid port of said second member, and wherein said first member and said second member themselves define an electrical connection between said electro-fluidic conductor and said electrical conductor when said electrical conductor is attached to said second member.

Claim 1 of Taillon et al corresponds to the proposed count.

Claim 24 of the above-referenced application corresponds to the proposed count. The terms of claim 24 are applied as follows:

24. A method for providing an electrical and fluid connector on an electro-fluidic conductor [COL. 1, LINES 15-19], said electrical and fluidic connector having a first member [2a] and a second member [2b] that are separate and both electrically conductive [COL. 4, LINES 49-50 AND 61-62], said second member having a fluid port that facilitates fluidic connection to a fluid conductor [COL. 4, LINES 3-4] and said second member being configured to facilitate electrical connection to an electrical conductor [COL. 6, LINES 44-46], said method comprising the steps of:

(a) securing said first member to said electro-fluidic

conductor such that said first member encircles an end portion of said electro-fluidic conductor and forms a fluid tight seal thereto [COL. 4, LINES 49-58; COL 6, LINES 30-36], and electrically connects therewith [COL. 6, LINES 44-46]; and

(b) matably connecting said first member to said second member such that said first member and said second member define a hollow inner chamber that comprises a fluid tight chamber for passing fluid between said electro-fluidic conductor and said fluid port of said second member [COL. 4, LINES 61-63; COL. 6, LINES 37-61], and wherein said first member and said second member themselves define an electrical connection between said electro-fluidic conductor and said electrical conductor when said electrical conductor is attached to said second member [COL. 6, LINES 44-46].

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,  
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Docket No. 0107-0974-3 REISSUE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN RE APPLICATION OF: ALFRED THIARD-LAFORET ET AL

FOR: METHOD FOR REPAIRING A CONNECTING DEVICE FOR THE ELECTRICAL CONNECTION  
AND FOR SUPPLYING AND CARRYING AWAY THE COOLANT TO AND FROM THE HOLLOW...

FILED: HEREWITH

LETTER

ASSISTANT COMMISSIONER FOR PATENTS  
WASHINGTON, D.C. 20231

SIR:

Listed below are the names and addresses of the inventors for the above-identified patent application.

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A declaration containing all the necessary information will be submitted at a later date.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,  
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